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Results on main cephalopods captured during the DEMERSALES bottom trawl surveys on the Northern Spanish Shelf

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Abstract

This paper presents the results on ten of the most important cephalopods species sampled during the DEMERSALES Spanish surveys form 1990 to 2011. The main species in biomass terms in this survey in decreasing abundance order were: curled octopus (*Eledone cirrhosa*), broadtail shortfin squid (*Illex coindetii*), lesser flying squid (*Todaropsis eblanae*), common octopus (*Octopus vulgaris*), long finned squid (*Loligo forbesi*), common squid (*Loligo vulgaris*), European flying squid (*Todarodes sagittatus*), pink cuttlefish (*Sepia orbignyana*), common cuttlefish (*Sepia officinalis*) and elegant cuttlefish (*Sepia elegans*). We present the geographic distribution and bathymetric abundance for these species. Length distributions of these species along the latest 5 years in the survey series are also presented and discussed.

1. Introduction

Cephalopod species are an important marine resource in the Northern Spain fisheries. Cephalopods are landed by both commercial and artisanal fleets, and landings from the latter have been relatively poorly documented in the past (Pierce *et al.*, 2010).

The bottom trawl survey on the Northern Spanish Shelf (SPNGFS: “DEMERSALES”) aim to provide data and information for the assessment of the commercial species and the ecosystems on the Galician and Cantabrian Shelf (ICES divisions VIIIc and IXa North). The DEMERSALES Spanish survey has been carried out annually in autumn from 1983, although data on invertebrate species were collected mainly from 1990, and therefore results are presented from this year up to 2011.

The aim of this working document is to present the results (abundance indices, length frequency distributions and geographic and bathymetric distributions) on the most common cephalopod species sampled in these surveys, namely curled octopus (*Eledone cirrhosa*), broadtail shortfin squid (*Illex coindetii*), lesser flying squid (*Todaropsis eblanae*), common octopus (*Octopus vulgaris*), long finned squid (*Loligo forbesi*), common squid (*Loligo vulgaris*), European flying squid (*Todarodes sagittatus*), pink cuttlefish (*Sepia orbignyana*), common cuttlefish (*Sepia officinalis*) and elegant cuttlefish (*Sepia elegans*) from the DEMERSALES bottom trawl survey's series.

2. Material and methods

The study area includes the Galician and Cantabrian Shelf from the River Miño mouth (10.0ºW) to the River Bidasoa mouth (2.2ºW) (Figure 1).

The data of species abundance (from 1990 to 2011) and length distribution (from 1997 to 2011) come from a series of bottom trawl surveys (DEMERSALES) carried out every autumn on board the R/V "Cornide de Saavedra" using standardized IBTS methodology from 1997 (ICES, 1997, 2010a, 2010b). The survey area was stratified according to depth (with three bathymetric strata: 70-120m, 121-200m, 201-500m) and geographical criteria (five predefined geographic sectors: Miño-Fisterra MF, Fisterra-Estaca de Bares FE, Estaca de Bares-Peñas EP, Peñas-Ajo PA and Ajo-Bidasoa AB) and a stratified random sampling scheme was adopted. Hauls shallower than 70 m and deeper than 500 m are considered additional hauls and performed every year if possible, thought they are not considered in the stratified abundance indices, nevertheless they are performed and plotted in the distribution maps. The information from these depths is considered relevant due to the changes in the depth of fishing activities in the area (Abad et al, 2010; Punzón et al, 2011a).

The fishing gear used in DEMERSALES Survey is an otter trawl sampler (BAKA 44/60) with a cod end mesh of 20 mm and a horizontal opening of 18.9 m, thus giving information on demersal and benthic megafauna (Olaso, 1990; Sánchez, 1993; Sánchez *et al.*, 1995; García-Castrillo and Olaso, 1995; Sánchez and Serrano, 2003). Standardized hauls are set during daylight, and towing time last 30 minutes between the end of wire shutting and starting to pull it back and towing speed was set to 3.0 Kn.

Evolution of abundance index is presented for each species along whole time series (1990-2011) in number and biomass by haul. To study geographic distribution trends we present species maps of plotted CPUE for fifteen years (1997-2011). To study bathymetric distribution of the species addressed, a histogram of depth of hauls performed along the time series was firstly performed obtaining the number of hauls per 50 m interval. Later the number of individuals in all the hauls performed in each depth interval was calculated and divided by the number of hauls.

Biological sampling of all catches of every cephalopod species was carried out from 2007. Individuals were weighted, measured (squids and cuttlefishes: total mantle length, octopuses: mantle length, measured from the posterior tip of the mantle to the midpoint between the eyes), sexed and maturity stage was examined following a standard protocol. The aim to obtain biological information about invertebrates is to improve the species knowledge and to be used in ecosystem modelling.

3. Results and discussion

3.1. Curled octopus (*Eledone cirrhosa*)

Curled octopus presents an irregular abundance in these surveys. It presented a slight decreasing trend in biomass during the latest years, with peaks in 1997 and 2001 and drops in 1998 and 2003; after a recovery during the period 2004-2007, biomass was low (0.4-0.8 Kg haul^{-1}) since 2008 (Figure 2). Curled octopus length sizes in this survey series (Figure 3) range from 1 to 25.4 cm. This species is distributed in all the survey area (Figure 4), especially in the westernmost area. Bathymetric distribution shows individuals in the whole range, with remarkable abundances between 100 - 300 m (Figure 5).

3.2. Broadtail shortfin squid (*Illex coindetii*)

The biomass abundance of shortfin squid is quite variable, with peaks every 2-3 years (Figure 6), which were mostly produced by hauls with high captures in the easternmost area (up to 2 Kg haul^{-1}). Nevertheless, the abundance of this species was also high in the Galician Shelf in 2000 (Figure 8). The variations in abundance are conditioned by the life cycle, spawning season and reproductive migrations, which determine geographic and seasonal variations (ICES, 2009). The *I. coindetii* sizes found in these surveys range between 3.1 and 25.8 cm, presenting a noteworthy mode in 14-16 cm (Figure 7). Bathymetrically, broadtail shortfin squid prefers the depths between 150 and 300 m, and almost no presence in grounds deeper than 400 m (Figure 9).

3.3. Lesser flying squid (*Todaropsis eblanae*)

Lesser flying squid also presented an irregular abundance in this surveys, with blooms in 1997 (up to 3 Kg haul^{-1}) and 1999 (~2 Kg haul^{-1}), and smaller new peaks in 2005 and 2011 (~1.5 Kg haul^{-1}) (Figure 10). Lesser flying squid individuals caught in the surveys vary from 1.1 and 28.0 cm, with a mode in 5-10 cm (Figure 11). This species is distributed in all the survey area (Figure 12). Bathymetric distribution of the species (Figure 13) reflects the preference of this species for depths between 150 and 350 m, though it appears in the whole water column to 600 m.

3.4. Common octopus (*Octopus vulgaris*)

Common octopus has similar biomass abundance values during the surveys series (lower than 1 kg haul^{-1}) (Figure 14), with a remarkable bloom in 1992 (~4 kg haul^{-1}). Common octopus length sizes in this surveys (Figure 15) range from 2.8 to 20.0 cm. This species is distributed in all the survey area (Figure 16). Bathymetric distribution (Figure 17) reflects the preference of this species for the shallowest grounds, with the highest abundances at depths lower than 100 m, and almost no presence in grounds deeper than 200 m.

3.5. Long finned squid (*Loligo forbesi*)

Long finned squid presents an irregular abundance in this surveys (Figure 18) that is relatively high between 2003 and 2006; it presents a drop in 2007-2008 (absence of capture) and a recovery in the latest years when the values were maximum (~0.8 kg haul^{-1}). The remaining years abundances were low (<0.2 kg haul^{-1}). The *L. forbesi* sizes found in these surveys range between 3.5 and 56.0 cm, presenting two noteworthy modes in 6-8 cm and another one in 23-27 cm (Figure

19). Regarding geographical distribution, long finned squid appears in the Cantabrian Shelf, especially at the easternmost areas (Figure 20), though the latest years the species is found at western positions (rarely at the west of Estaca). Bathymetrically, long finned squid also prefers shallowest areas (Figure 21), with the highest abundances lower than 50 m (special hauls), and almost no presence in grounds deeper than 350 m.

3.6. Common squid (*Loligo vulgaris*)

Common squid also presents an irregular abundance (Figure 22) with low values in general (lower than 0.2 kg haul^{-1}), except during the periods 1995-1997 (~0.3 kg haul^{-1}) and 2006-2009 (~0.3-0.5 kg haul^{-1}). The capture was scarce in 2010 and 2011. The *L. vulgaris* sizes found in these surveys range between 2.2 and 55.0 cm; the most frequent were the smallest specimens (Figure 23). The area occupied by common squid is very similar to the long finned squid (Figure 24), however this species can also be found in the Galician Shelf. Bathymetric distribution (Figure 25) reflects the preference of this species for the shallowest grounds, with the highest abundances at depths lower than 50 m (special hauls), and almost no presence in grounds deeper than 100 m.

3.7. European flying squid (*Todarodes sagittatus*)

European flying squid has similar biomass abundance values during the surveys series (lower than 0.2 kg haul^{-1}) (Figure 26), with a remarkable bloom in 1994 (~0.7 kg haul^{-1}) and smaller new peaks in 2006 and 2009 (~0.3 kg haul^{-1}). European flying squid length sizes in these surveys (Figure 27) range from 10.7 to 40.2 cm. This species is distributed in all the survey area (Figure 28), especially in the north of the Galician Shelf. Bathymetric distribution (Figure 29) reflects the preference of this species for deeper grounds, with the highest abundances at depths between 400 and 550 m.

3.8. Pink Cuttlefish (*Sepia orbignyana*)

The biomass abundance of pink cuttlefish is quite variable, with peaks every 4-5 years (Figure 30) (up to 0.15 Kg haul^{-1}). The *S. orbignyana* sizes found in these surveys range between 1.0 and 9.6 cm (Figure 31). This species is distributed in all the Cantabrian Shelf, with concentrations in the sectors EB (Estaca-Bares) and BP (Bares-Peñas) (Figure 32). Bathymetrically, pink cuttlefish prefers the shallowest grounds (between 50 and 150 m), and almost no presence in grounds deeper than 200 m (Figure 33).

3.9. Common cuttlefish (*Sepia officinalis*)

Presence of common cuttlefish is very scarce in the DEMERSALES surveys (Figure 34) due to its bathymetric preferences (shallower than those covered in this survey). The years with higher abundances were 1996 and 2006 (the biomass index was 0.15-0.2 kg haul^{-1}). The *S. officinalis* sizes found in these surveys range between 5.6 and 20.5 cm. The low number of common cuttlefish captured during the latest five years did not allow us to display any length distribution. Regarding geographical distribution, common cuttlefish appears at the easternmost areas of the Cantabrian Shelf (Figure 35). Bathymetric distribution shows the peak of abundance under 50 m and no presence of this species deeper than 100 m (Figure 36).

3.10. Elegant cuttlefish (*Sepia elegans*)

The biomass abundance of elegant cuttlefish is similar during the series, with a small peak in 1997 and a smaller one in 2009 (~0.1 kg haul^{-1}) (Figure 37). The *S. elegans* sizes found in these surveys range between 0.5 and 7.4 cm (Figure 38). The geographical preferences of elegant cuttlefish are Asturias and Galician Shelves (Figure 39). Bathymetric distribution of the species (Figure 40) reflects the shallow habits of this species that only occurs in grounds between 50 and 100 m.

Acknowledgements

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FIGURES

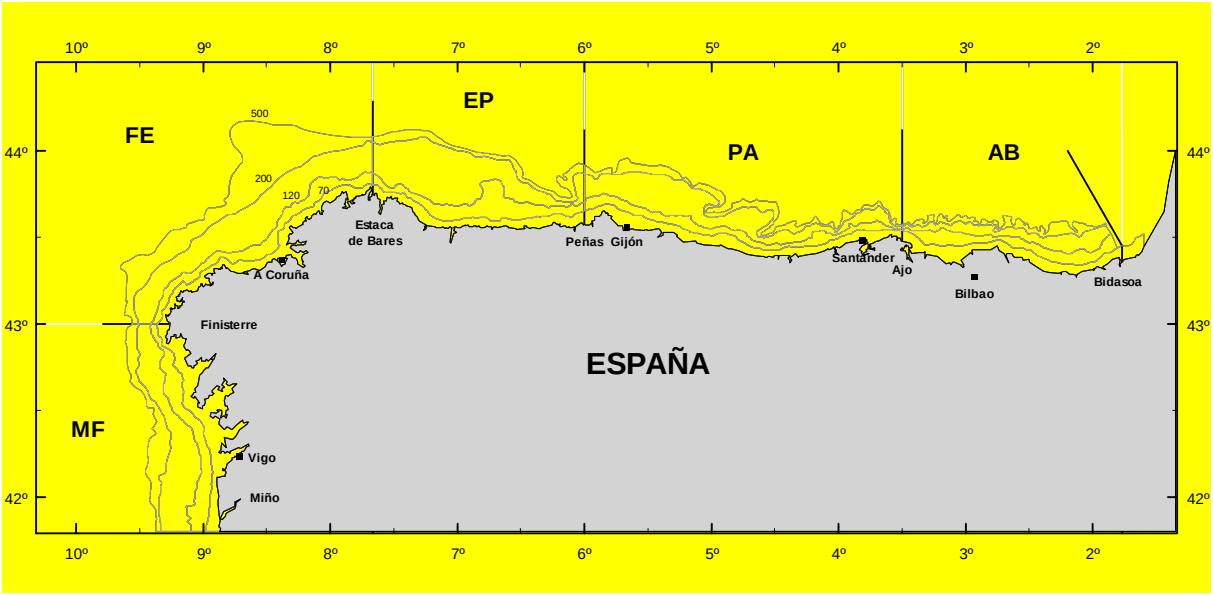

Figure 1. Stratification design on the Demersales surveys (ICES divisions VIIIc and IXa North). Depth strata are: A) 70-120 m, B) 121-200 m, and C) 201-500 m. Geographic transects are MF: Miño-Finisterre, FE: Finisterre-Estaca, EP: Estaca-Peñas, PA: Peñas-Ajo, and AB: Ajo-Bidasoa

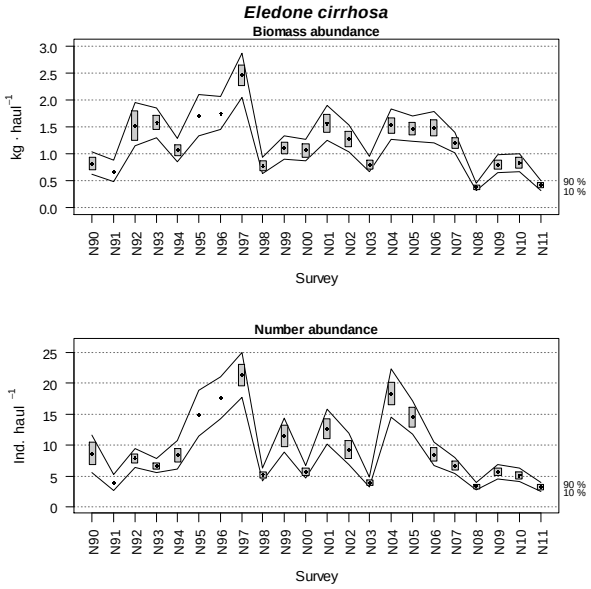

Figure 2. Evolution of biomass and abundance index in curled octopus (*Eledone cirrhosa*) during DEMERSALES Survey time series (1990-2011)

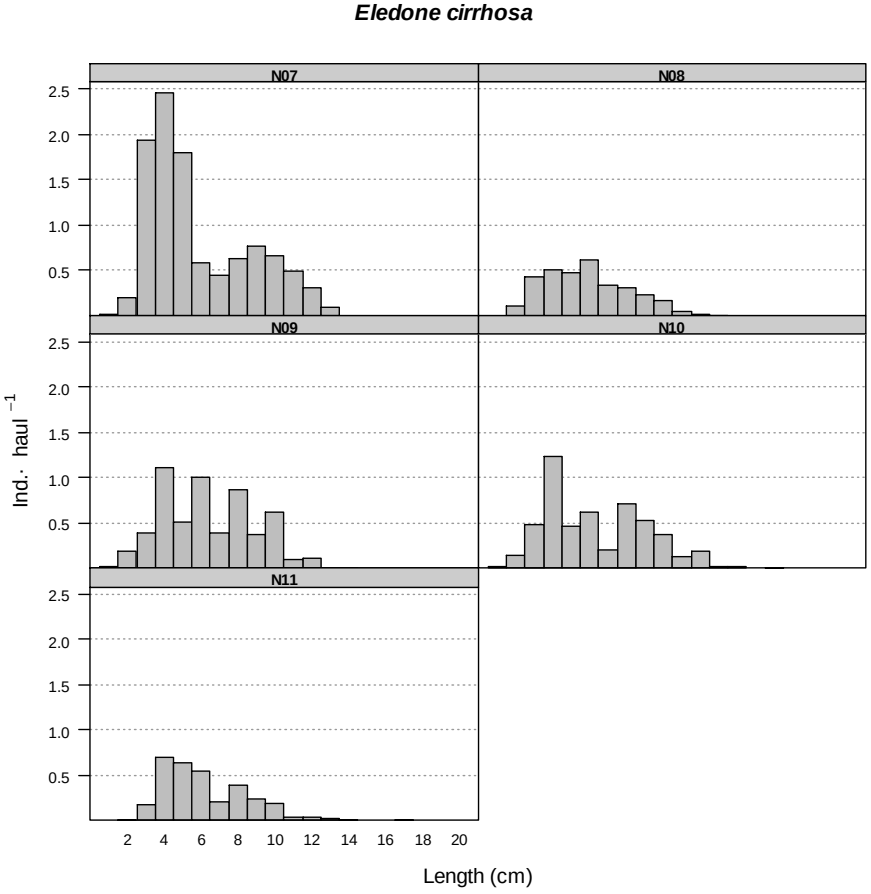

Figure 3. Length distributions of curled octopus (*Eledone cirrhosa*) during DEMERSALES Survey time series (2008-2011)

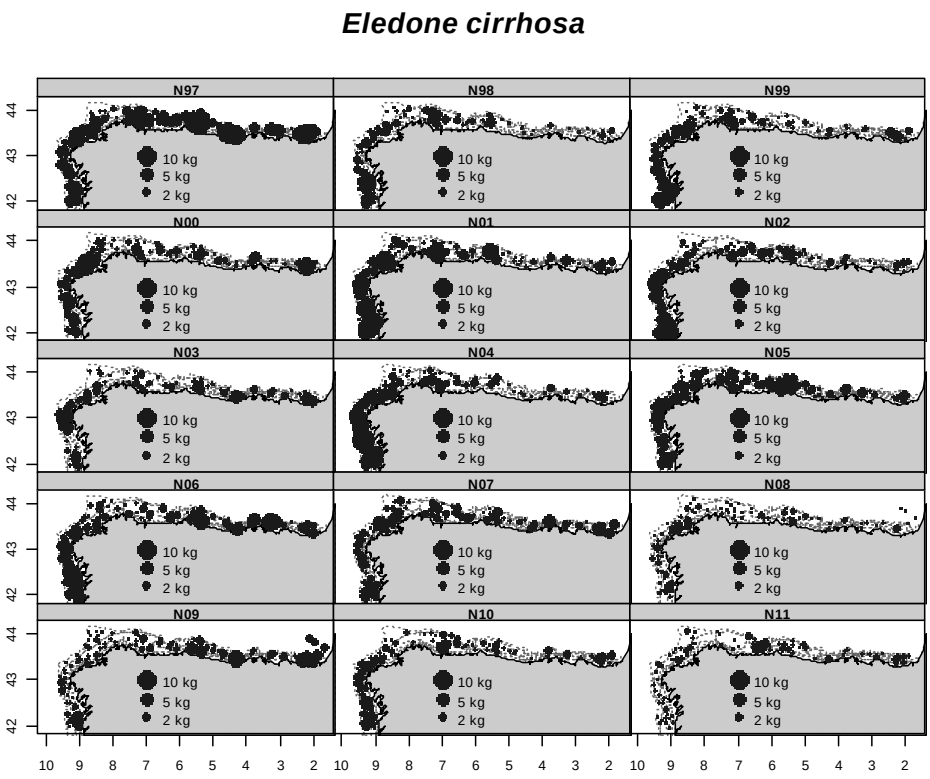

Figure 4. Geographic distribution of curled octopus (*Eledone cirrhosa*) during DEMERSALES Survey time series (1997-2011)

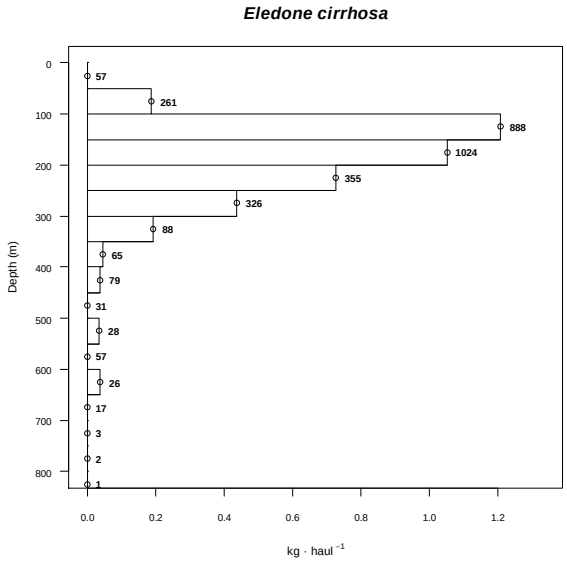

Figure 5. Bathymetric distribution of curled octopus (*Eledone cirrhosa*) catches (ind. haul^{-1}) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

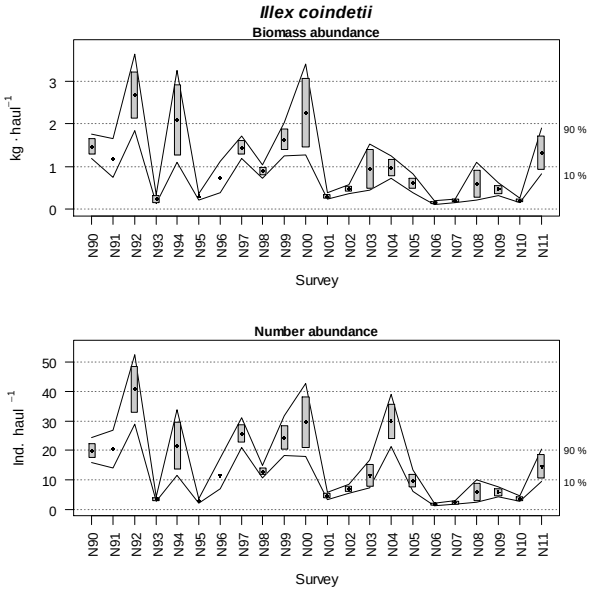

Figure 6. Evolution of biomass and abundance index in broadtail shortfin squid (*Illex coindetii*) during DEMERSALES Survey time series (1990-2011).

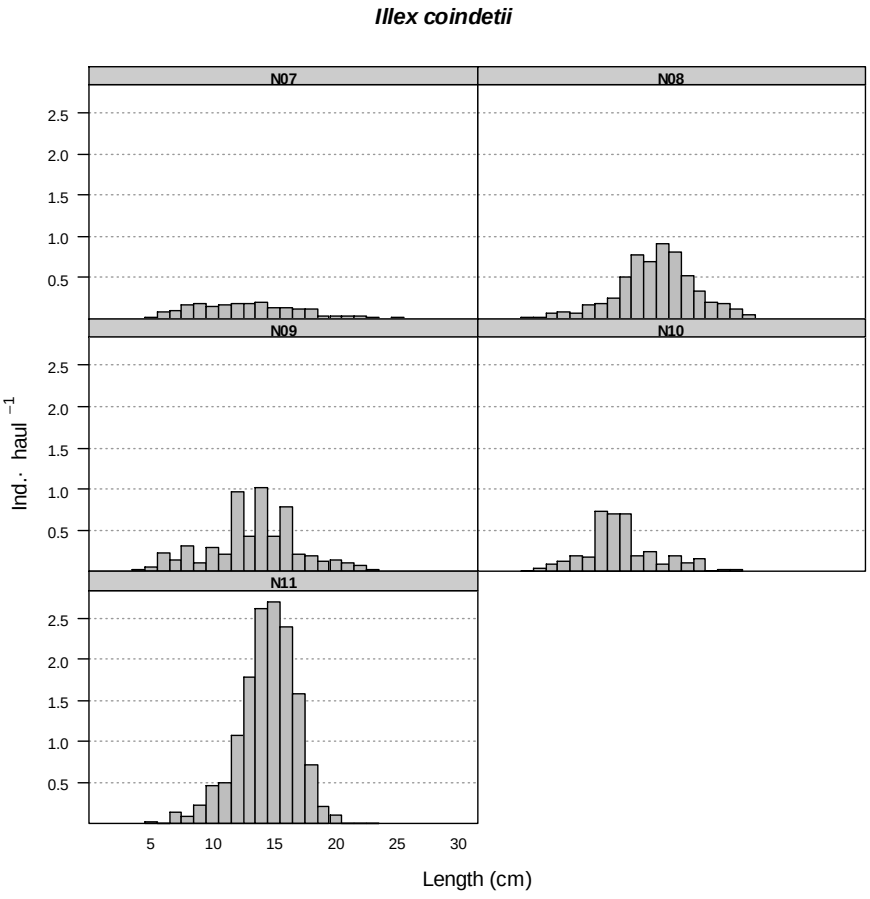

Figure 7. Length distributions of broadtail shortfin squid (*Illex coindetii*) during DEMERSALES Survey time series (2008-2011)

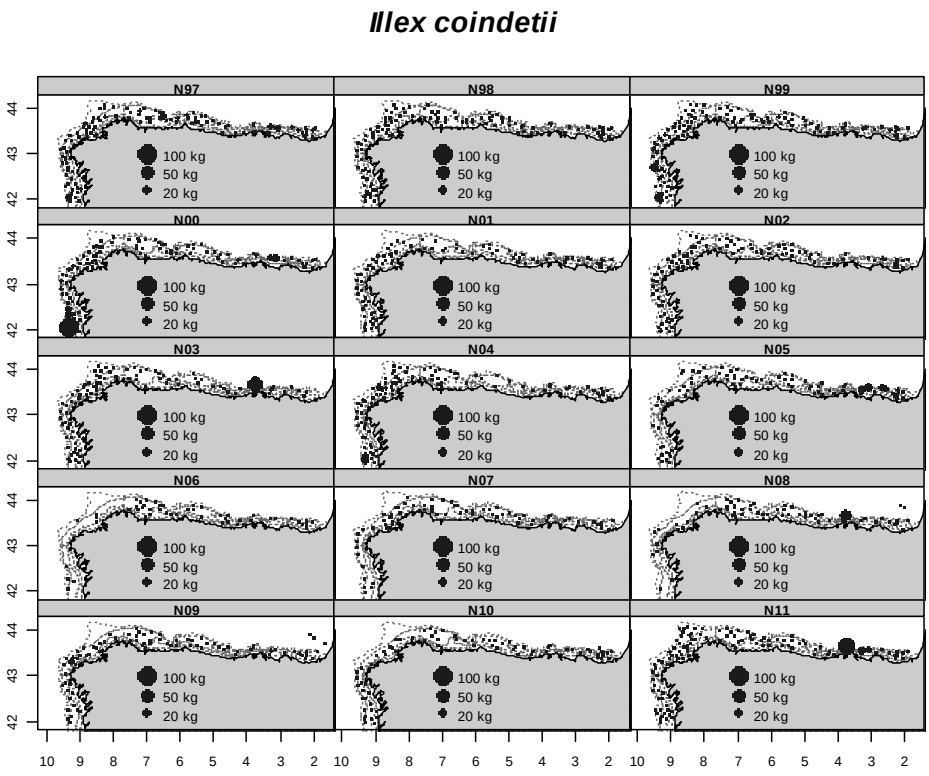

Figure 8. Geographic distribution of broadtail shortfin squid (*Illex coindetii*) during DEMERSALES Survey time series (1997-2011)

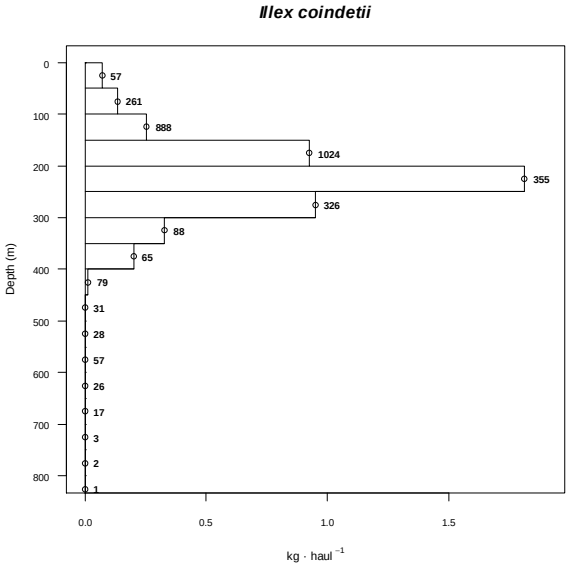

Figure 9. Bathymetric distribution of shortfin squid (*Illex coindetii*) catches (ind. haul^{-1}) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

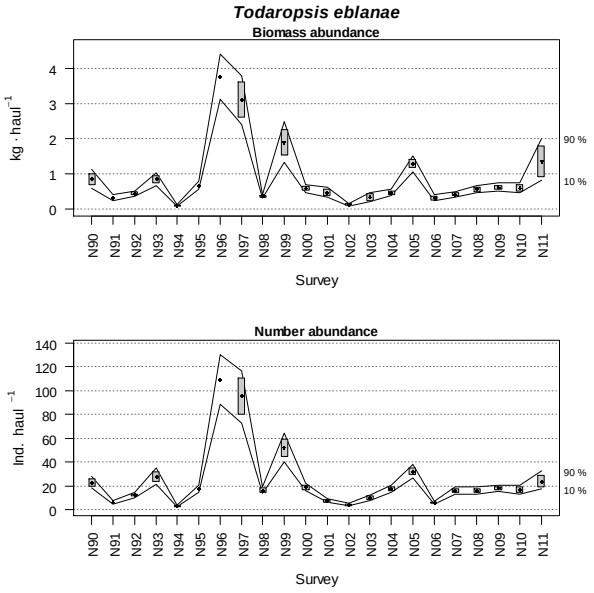

Figure 10. Evolution of biomass and abundance index in lesser flying squid (*Todaropsis eblanae*) during DEMERSALES Survey time series (1990-2011)

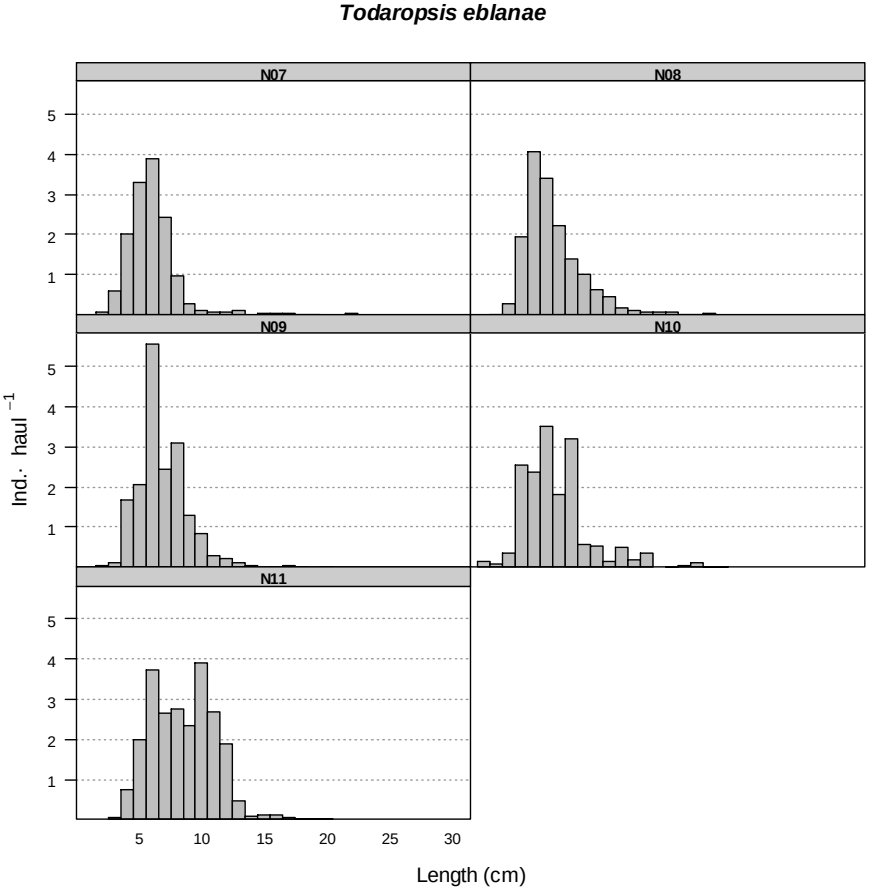

Figure 11. Length distributions of lesser flying squid (*Todaropsis eblanae*) during DEMERSALES Survey time series (2008-2011)

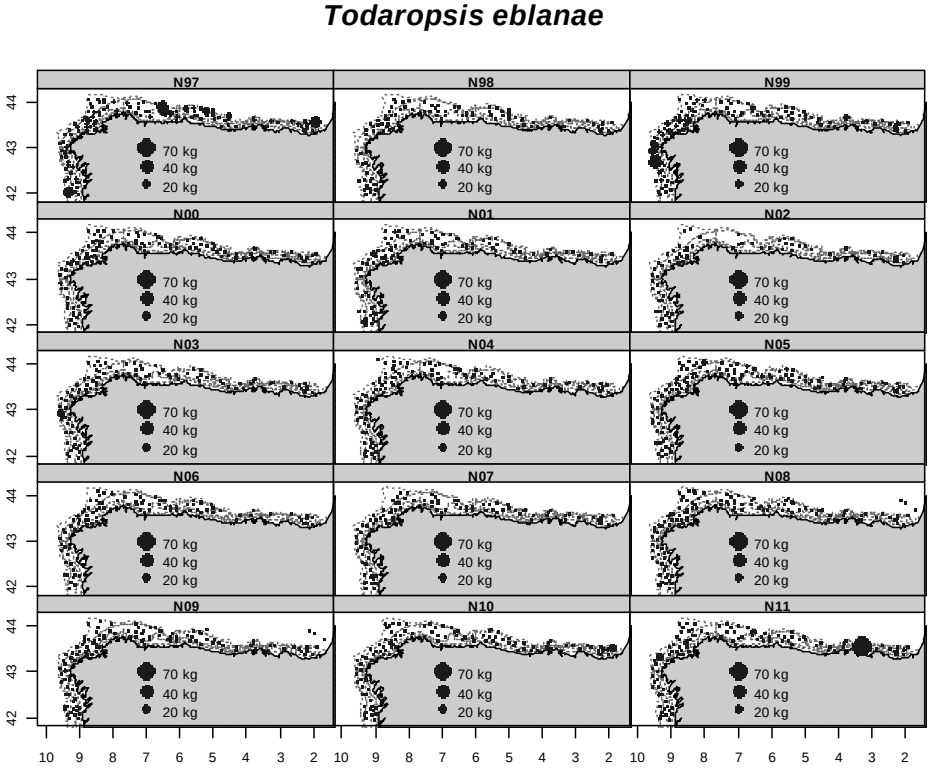

Figure 12. Geographic distribution of lesser flying squid (*Todaropsis eblanae*) during DEMERSALES Survey time series (1997-2011)

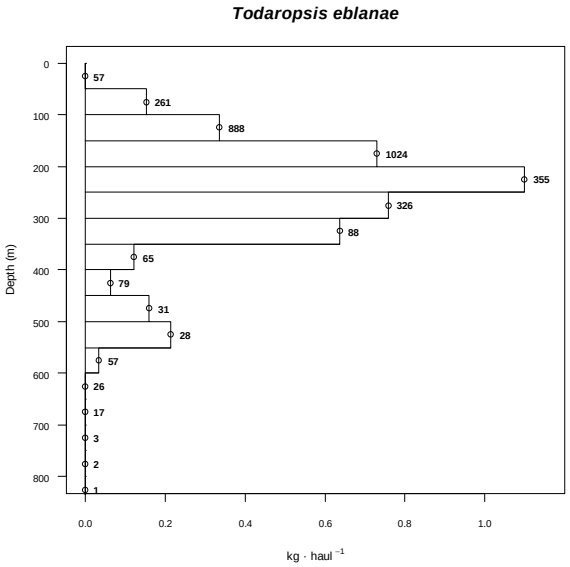

Figure 13. Bathymetric distribution of flying squid (*Todaropsis eblanae*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

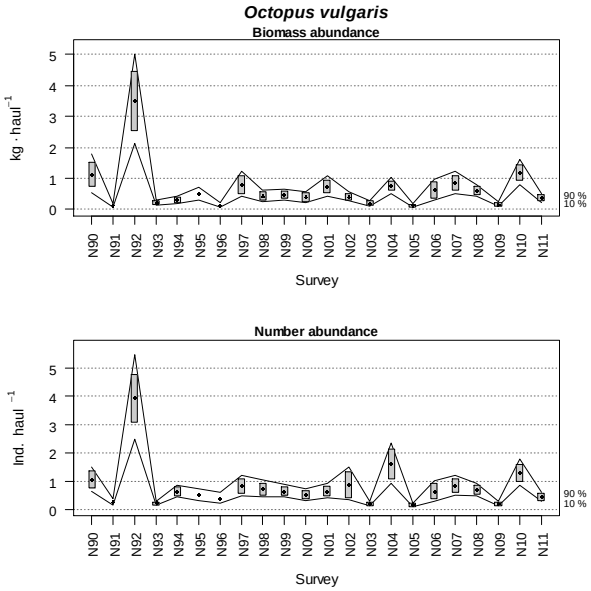

Figure 14. Evolution of biomass and abundance index in common octopus (*Octopus vulgaris*) during DEMERSALES Survey time series (1990-2011)

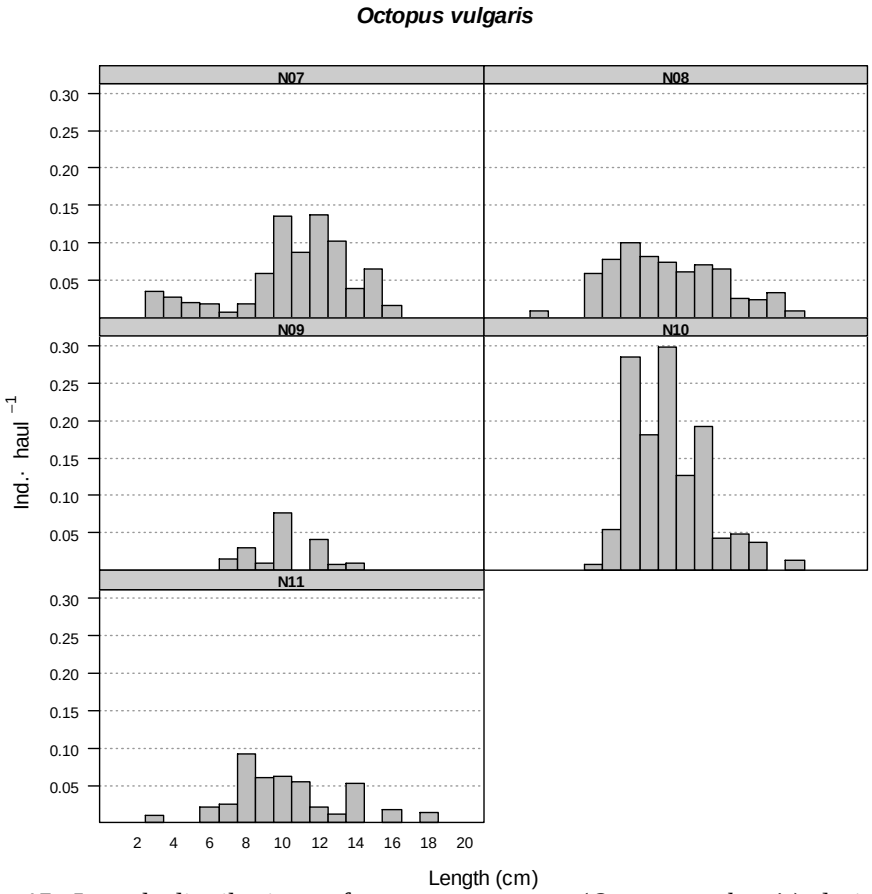

Figure 15. Length distributions of common octopus (*Octopus vulgaris*) during DEMERSALES Survey time series (2008-2011)

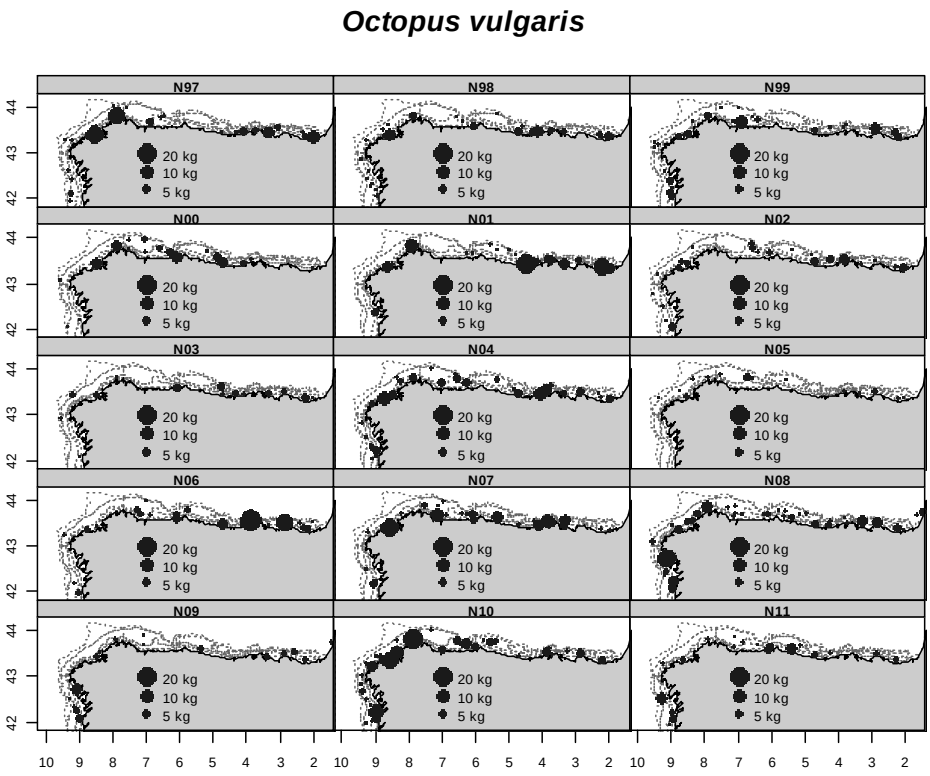

Figure 16. Geographic distribution of common octopus (*Octopus vulgaris*) during DEMERSALES Survey time series (1997-2011)

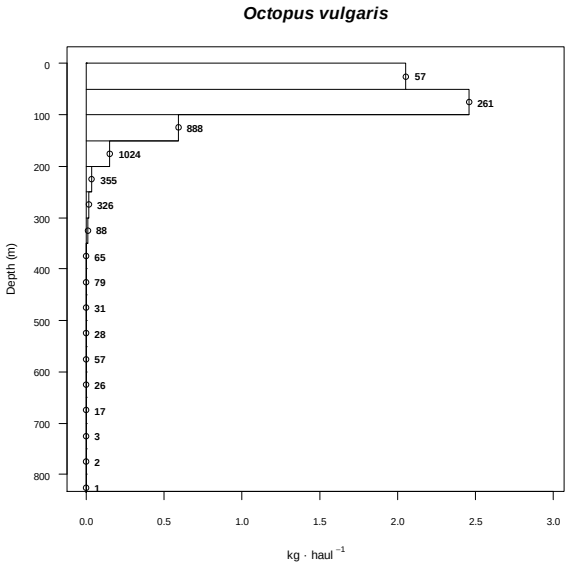

Figure 17. Bathymetric distribution of common octopus (*Octopus vulgaris*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

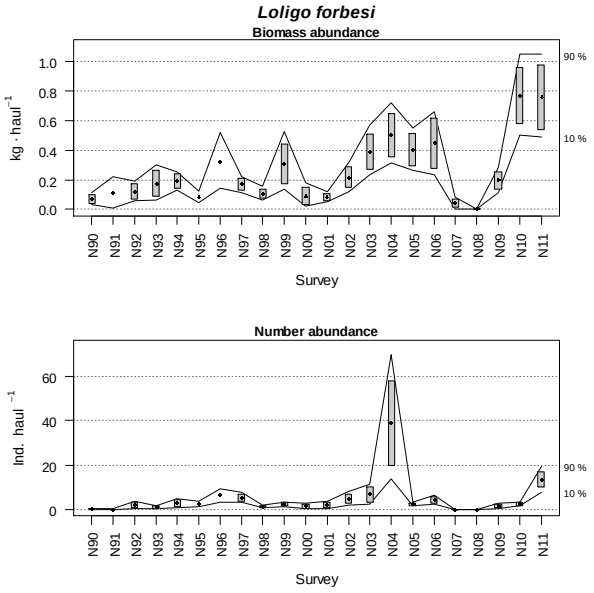

Figure 18. Evolution of biomass and abundance index in long finned squid (*Loligo forbesi*) during DEMERSALES Survey time series (1990-2011)

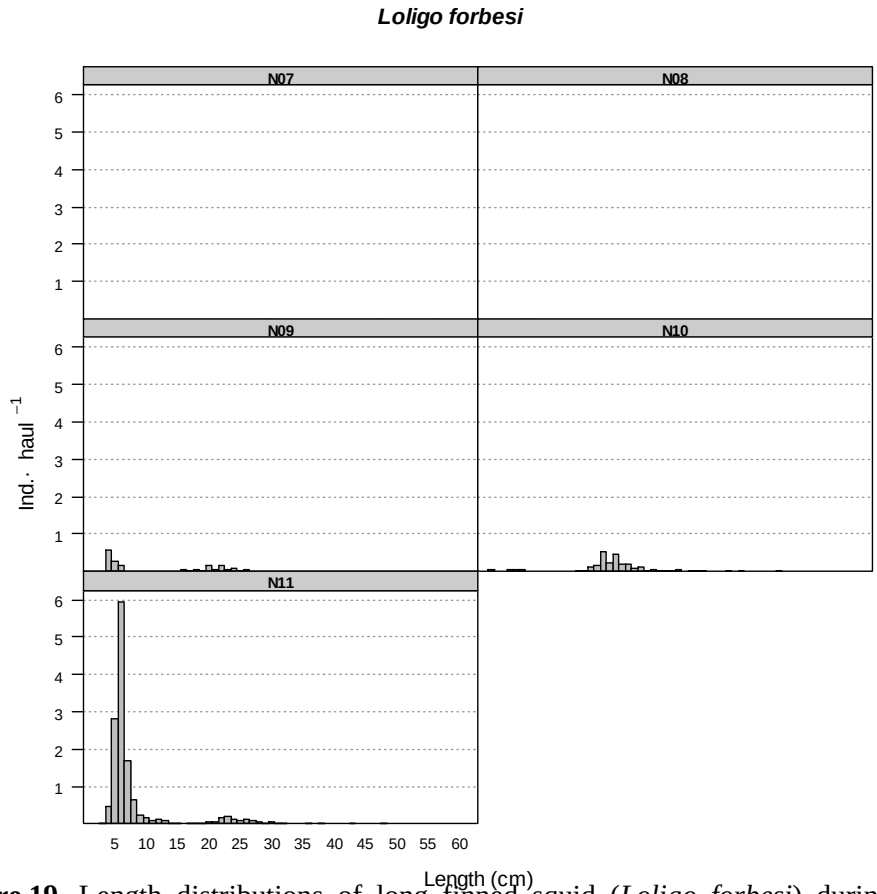

Figure 19. Length distributions of long finned squid (*Loligo forbesi*) during DEMERSALES Survey time series (2008-2011)

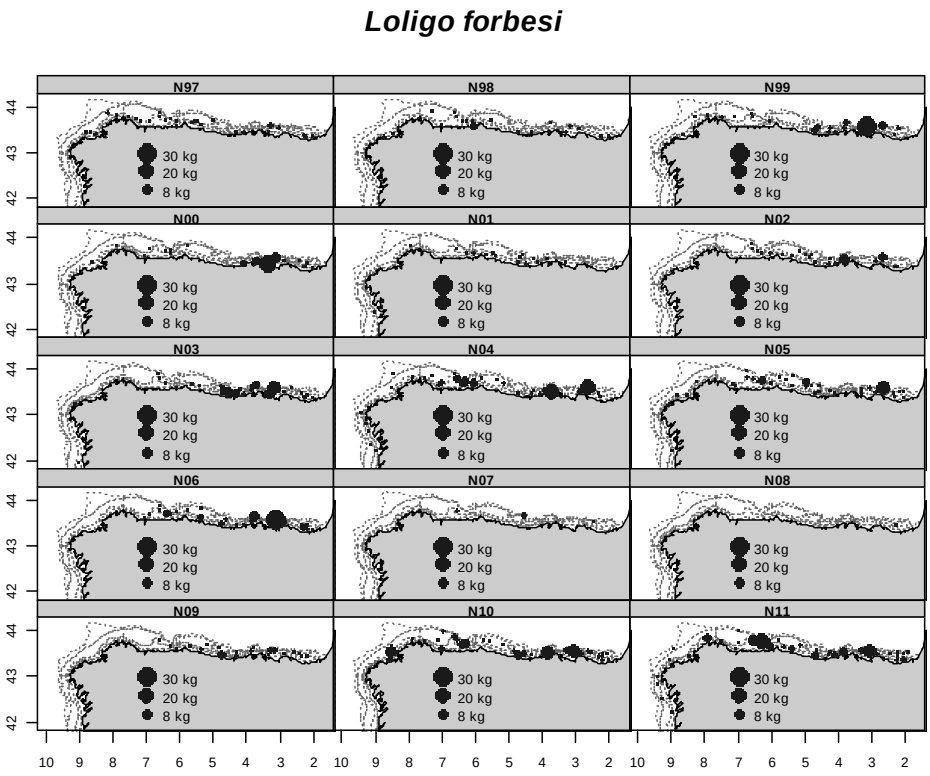

Figure 20. Geographic distribution of long finned squid (*Loligo forbesi*) during DEMERSALES Survey time series (1997-2011)

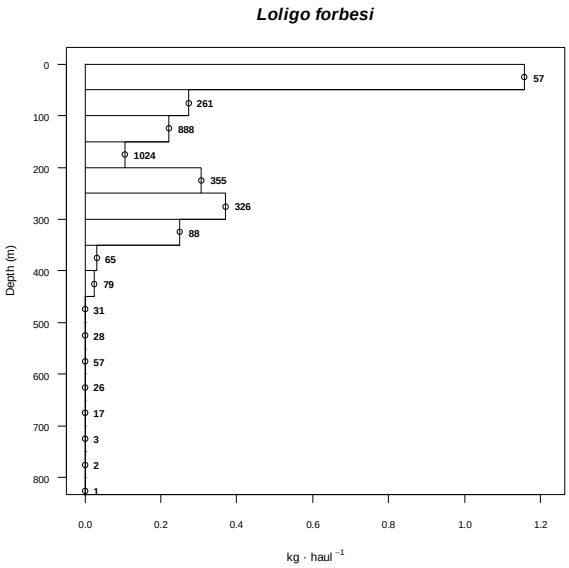

Figure 21. Bathymetric distribution of finned squid (*Loligo forbesi*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

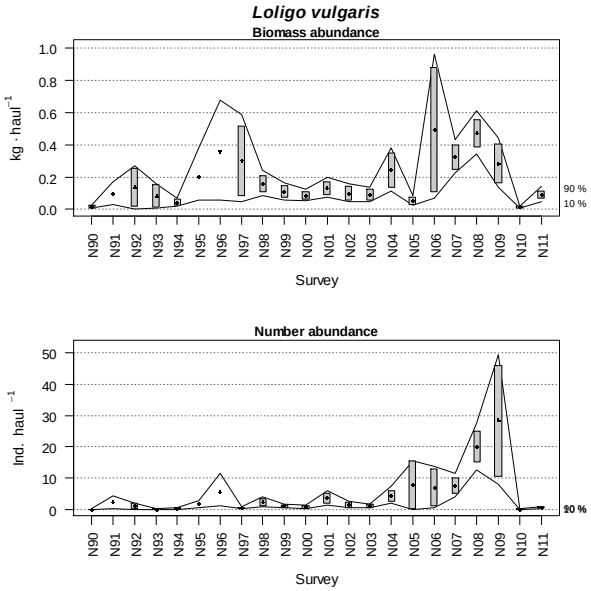

Figure 22. Evolution of biomass and abundance index in common squid (*Loligo vulgaris*) during DEMERSALES Survey time series (1990-2011)

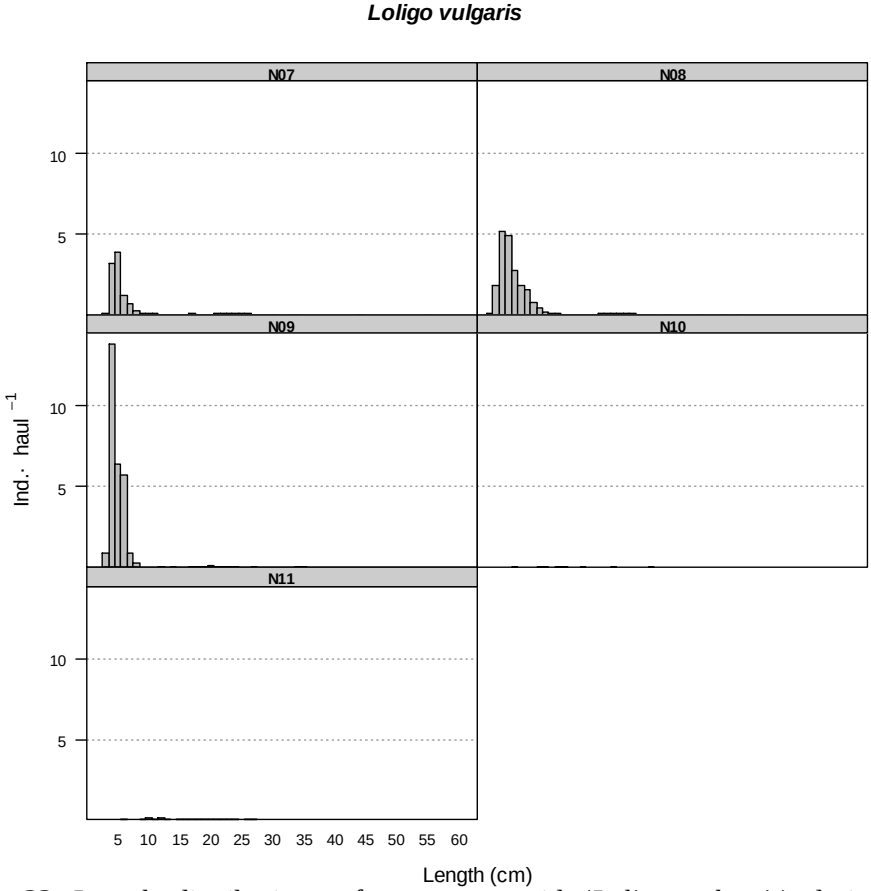

Figure 23. Length distributions of common squid (*Loligo vulgaris*) during DEMERSALES Survey time series (2008-2011)

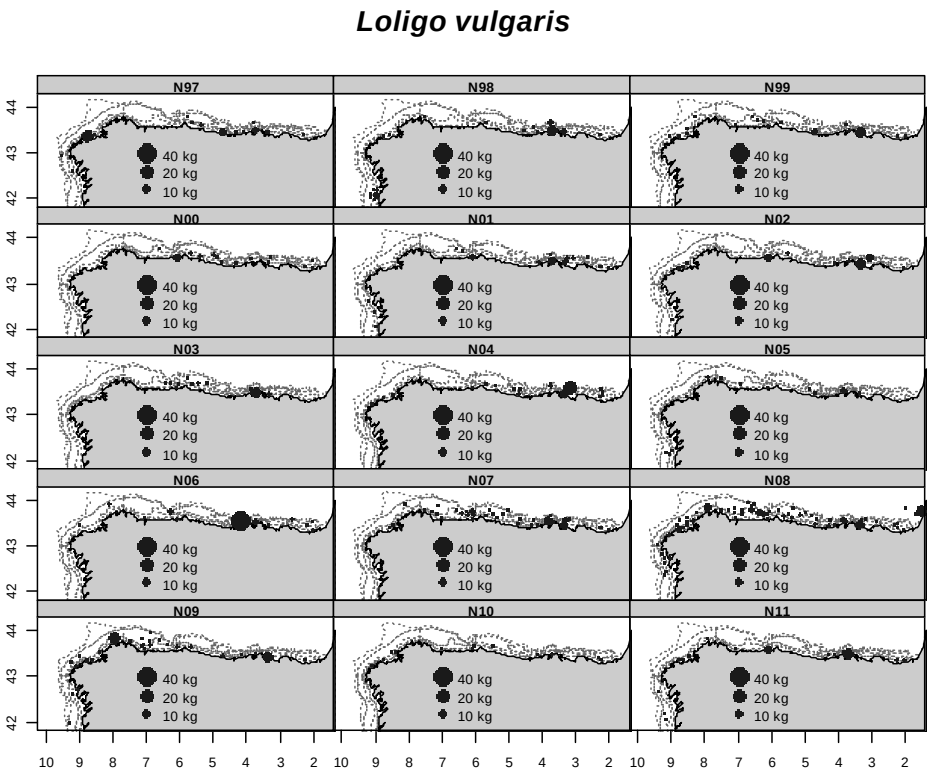

Figure 24. Geographic distribution of common squid (*Loligo vulgaris*) during DEMERSALES Survey time series (1997-2011)

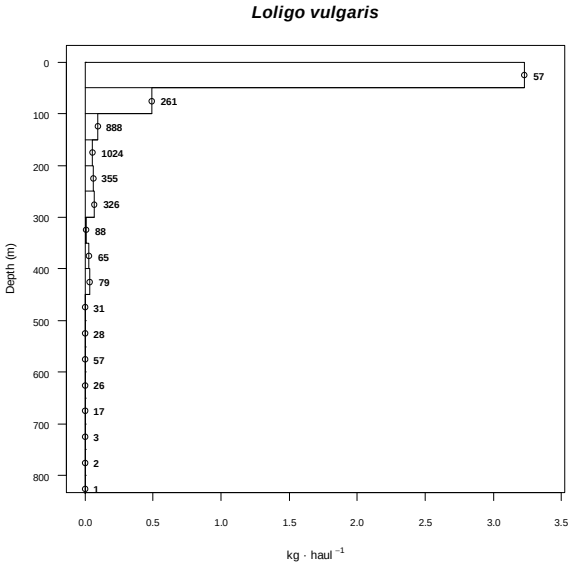

Figure 25. Bathymetric distribution of common squid (*Loligo vulgaris*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure

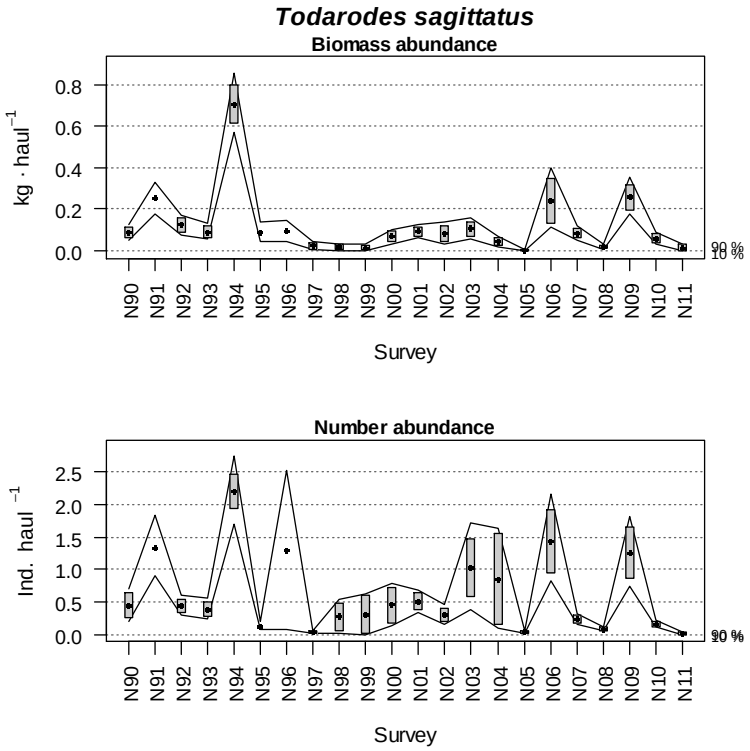

Figure 26. Evolution of biomass and abundance index in European flying squid (*Todarodes sagittatus*) during DEMERSALES Survey time series (1990-2011).

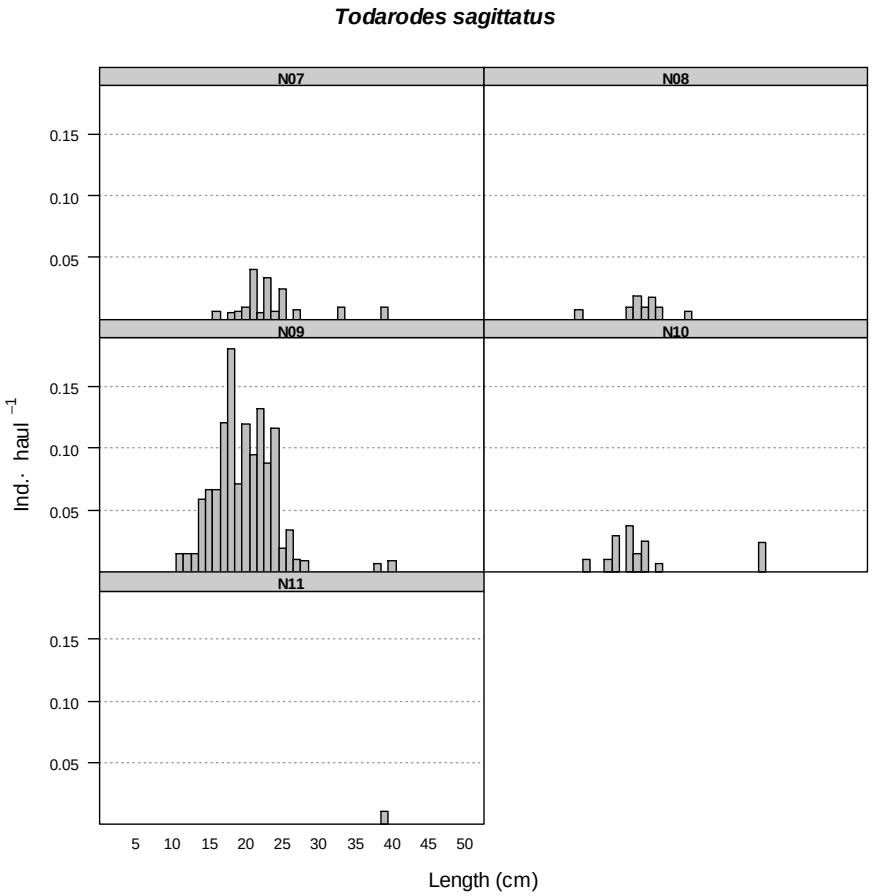

Figure 27. Length distributions of European flying squid (*Todarodes sagittatus*) during DEMERSALES Survey time series (2008-2011).

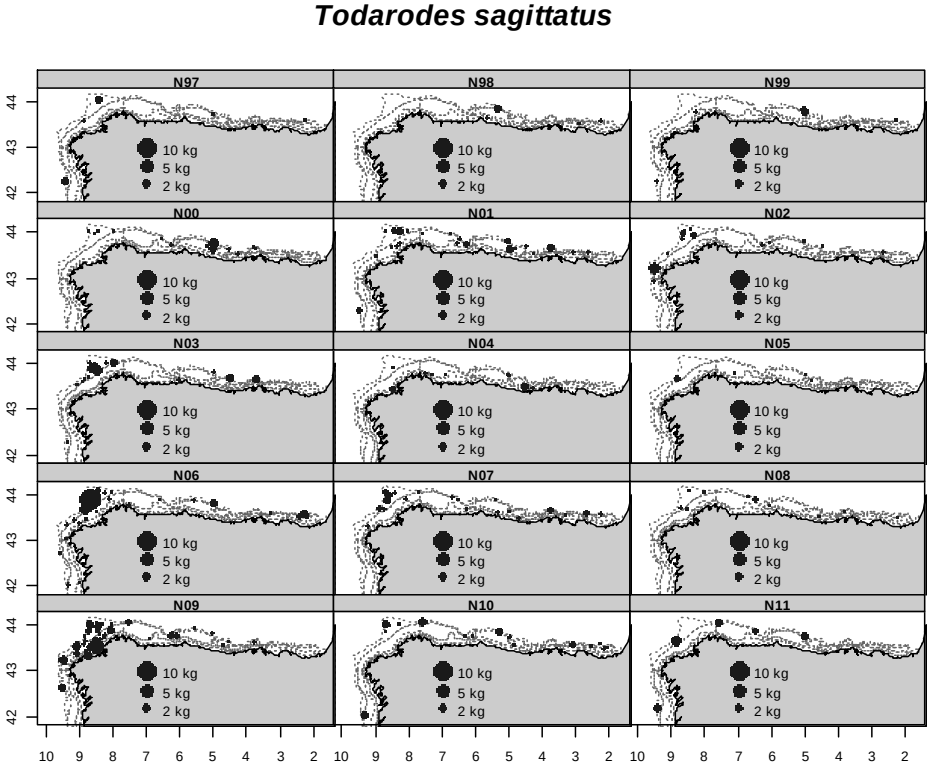

Figure 28. Geographic distribution of European flying squid (*Todarodes sagittatus*) during DEMERSALES Survey time series (1997-2011).

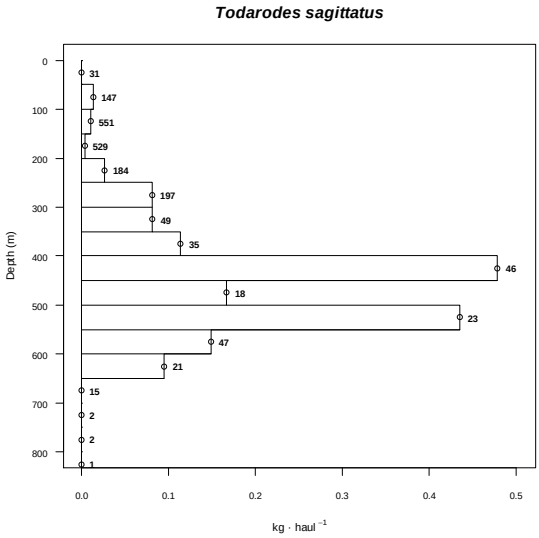

Figure 29. Bathymetric distribution of European flying squid (*Todarodes sagittatus*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure.

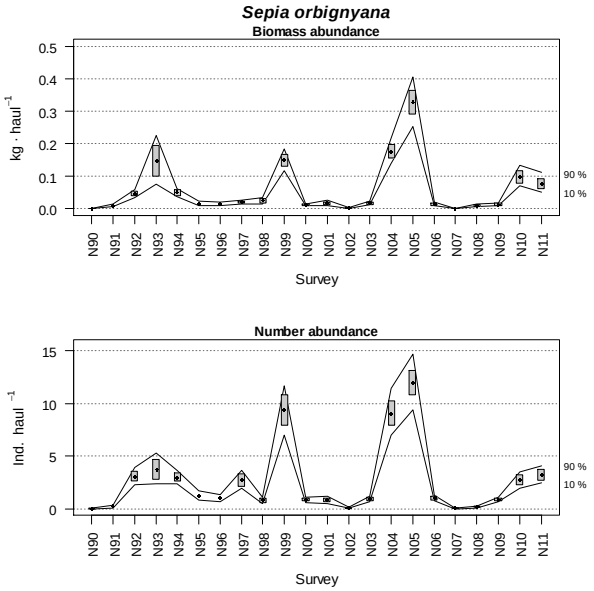

Figure 30. Evolution of biomass and abundance index in pink cuttlefish (*Sepia orbignyana*) during DEMERSALES Survey time series (1990-2011).

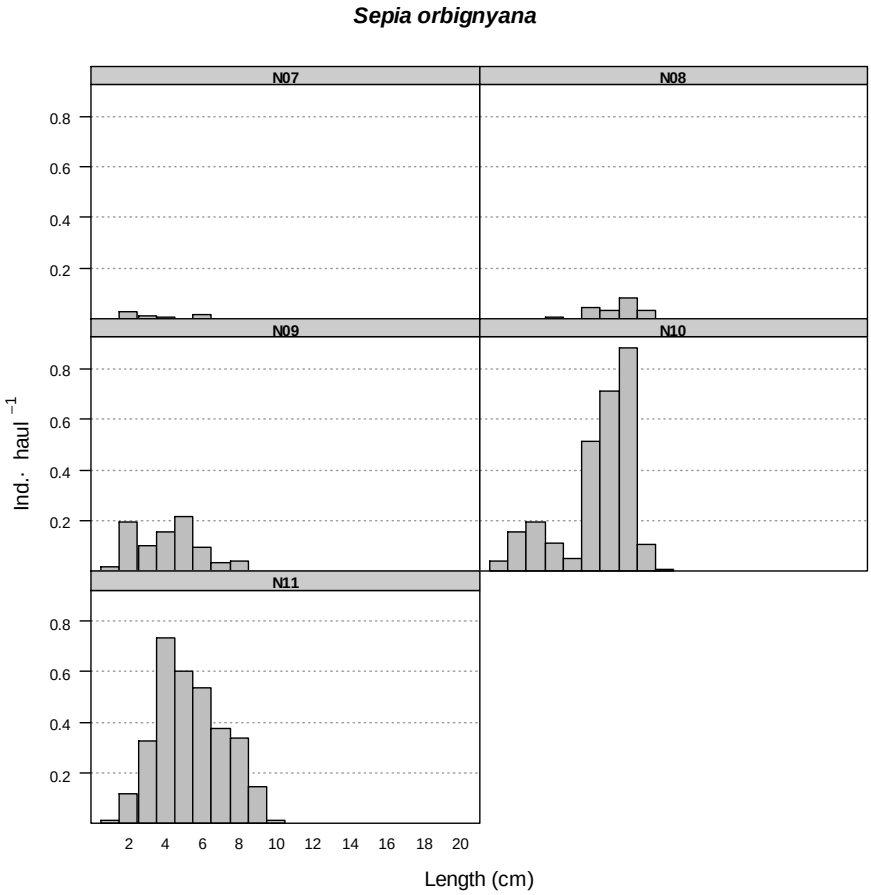

Figure 31. Length distributions of pink cuttlefish (*Sepia orbignyana*) during DEMERSALES Survey time series (2008-2011).

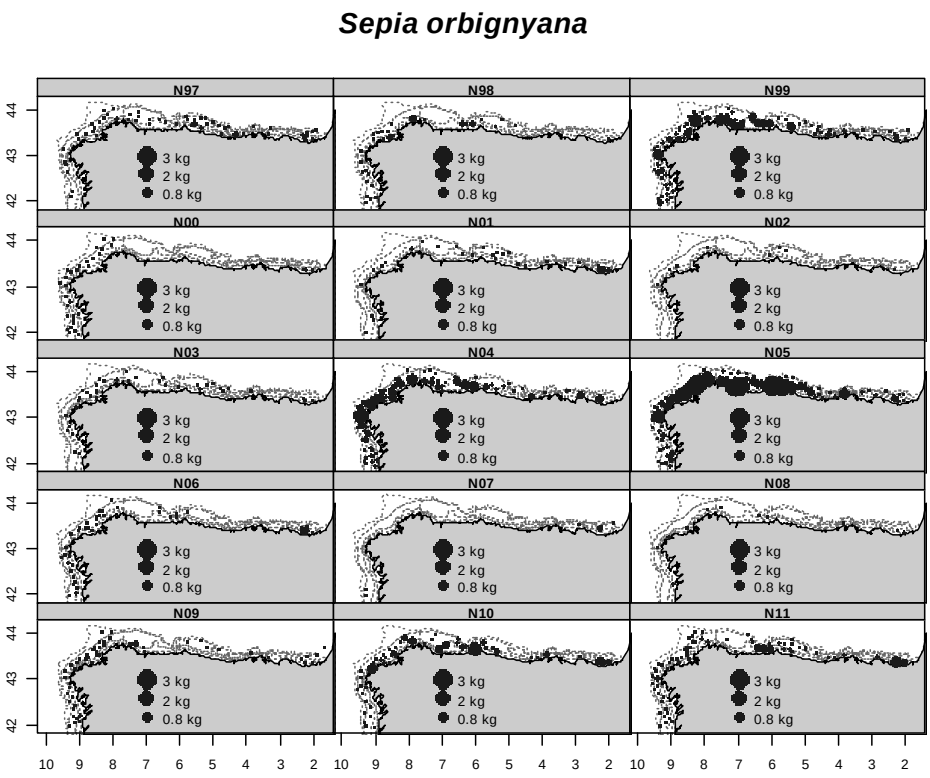

Figure 32. Geographic distribution of pink cuttlefish (*Sepia orbignyana*) during DEMERSALES Survey time series (1997-2011).

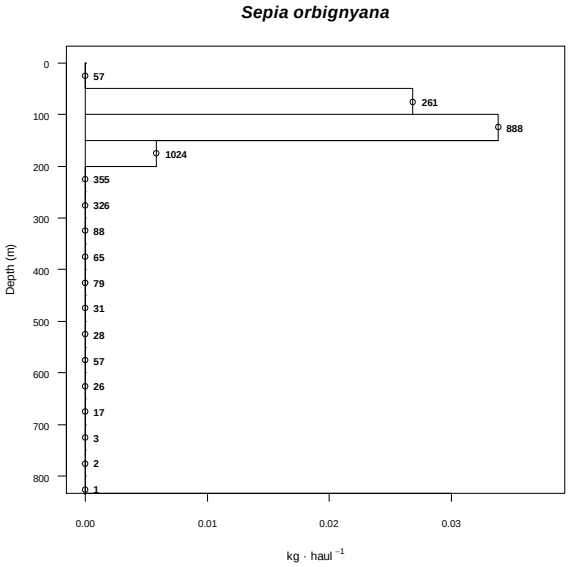

Figure 33. Bathymetric distribution of pink cuttlefish (*Sepia orbignyana*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure.

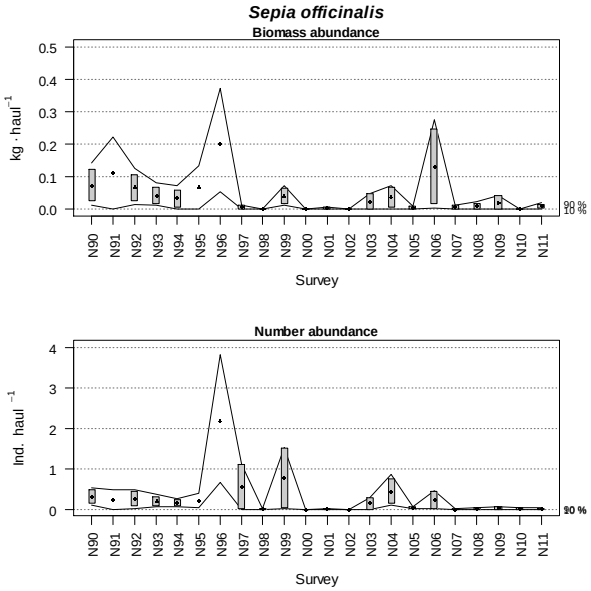

Figure 34. Evolution of biomass and abundance index in common cuttlefish (*Sepia officinalis*) during DEMERSALES Survey time series (1990-2011).

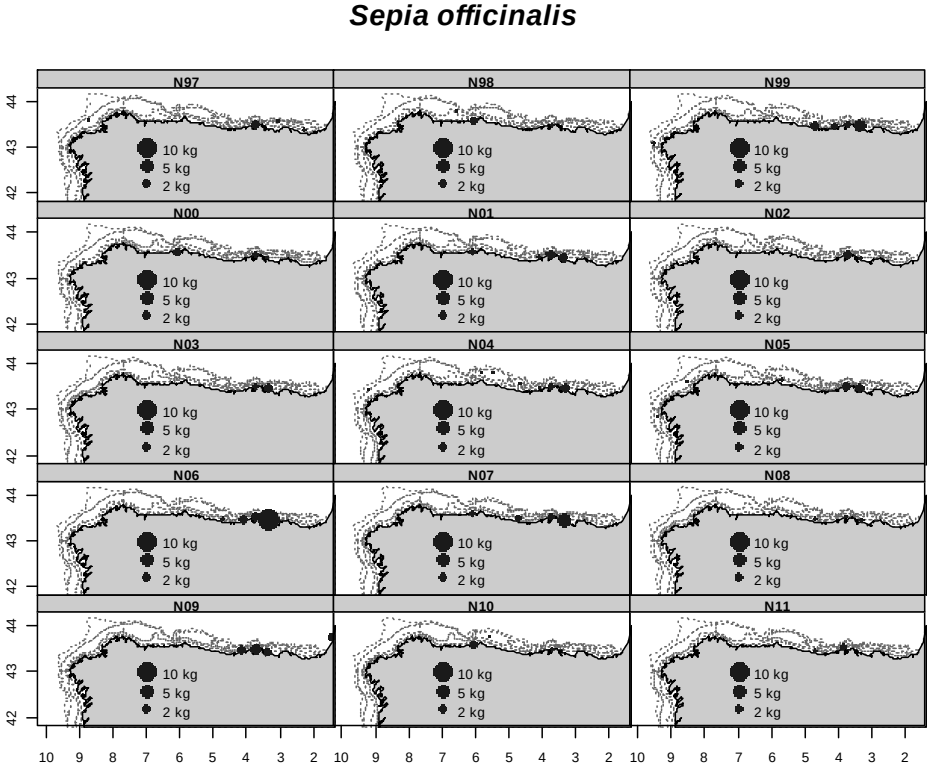

Figure 35. Geographic distribution of common cuttlefish (*Sepia officinalis*) during DEMERSALES Survey time series (1997-2011).

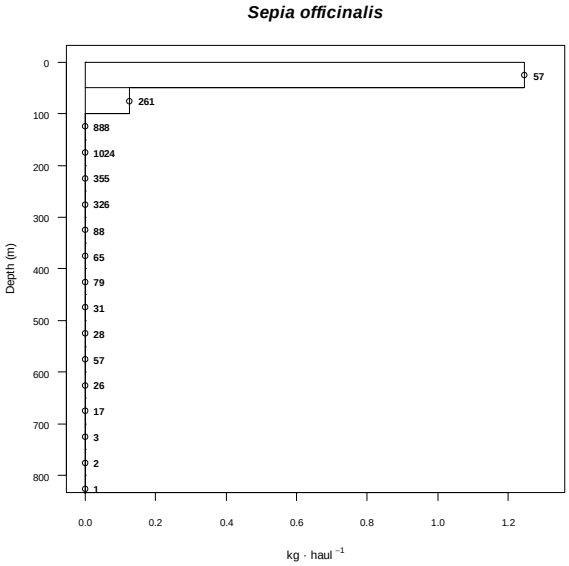

Figure 36. Bathymetric distribution of common cuttlefish (*Sepia officinalis*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure.

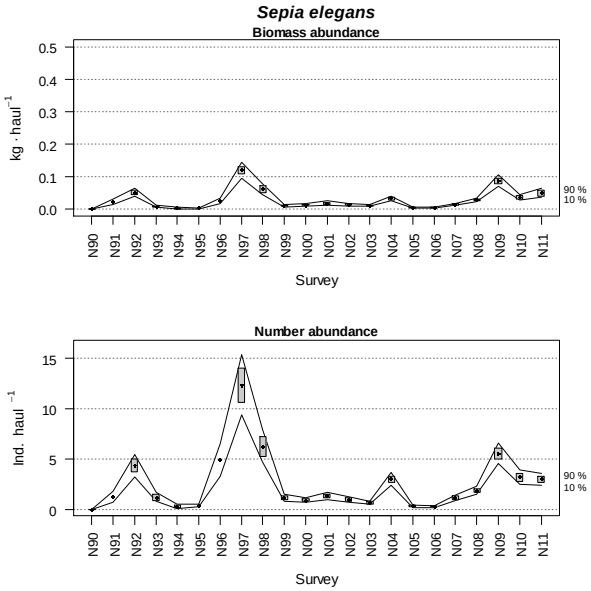

Figure 37. Evolution of biomass and abundance index in elegant cuttlefish (*Sepia elegans*) during DEMERSALES Survey time series (1990-2011).

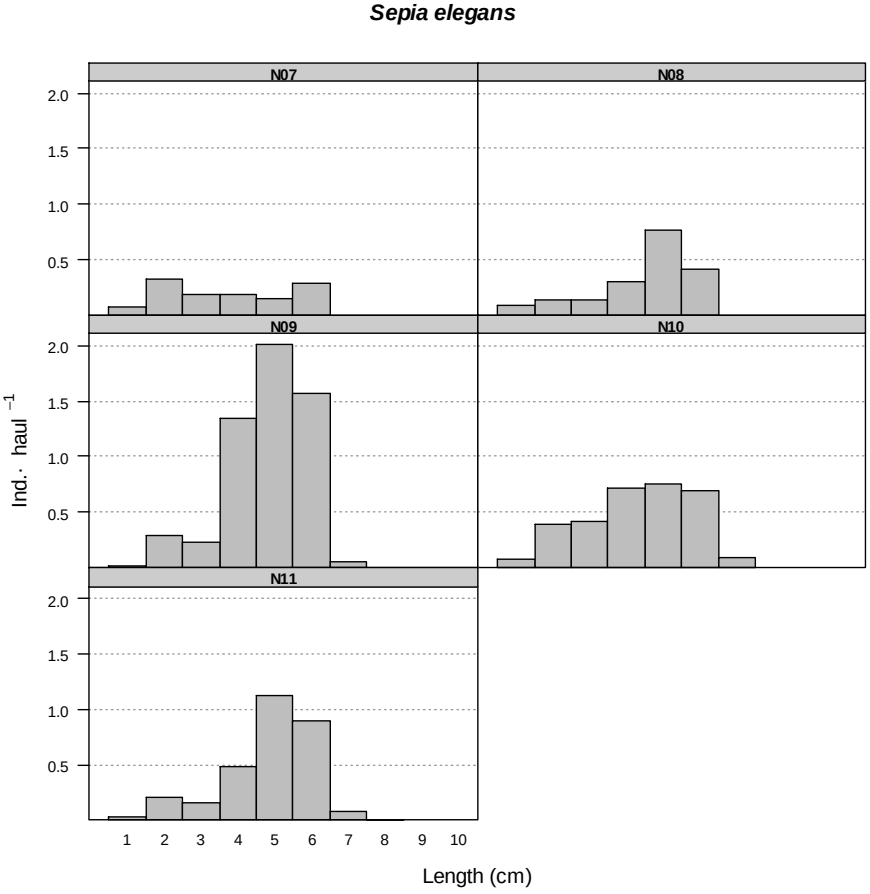

Figure 38. Length distributions of elegant cuttlefish (*Sepia elegans*) during DEMERSALES Survey time series (2008-2011).

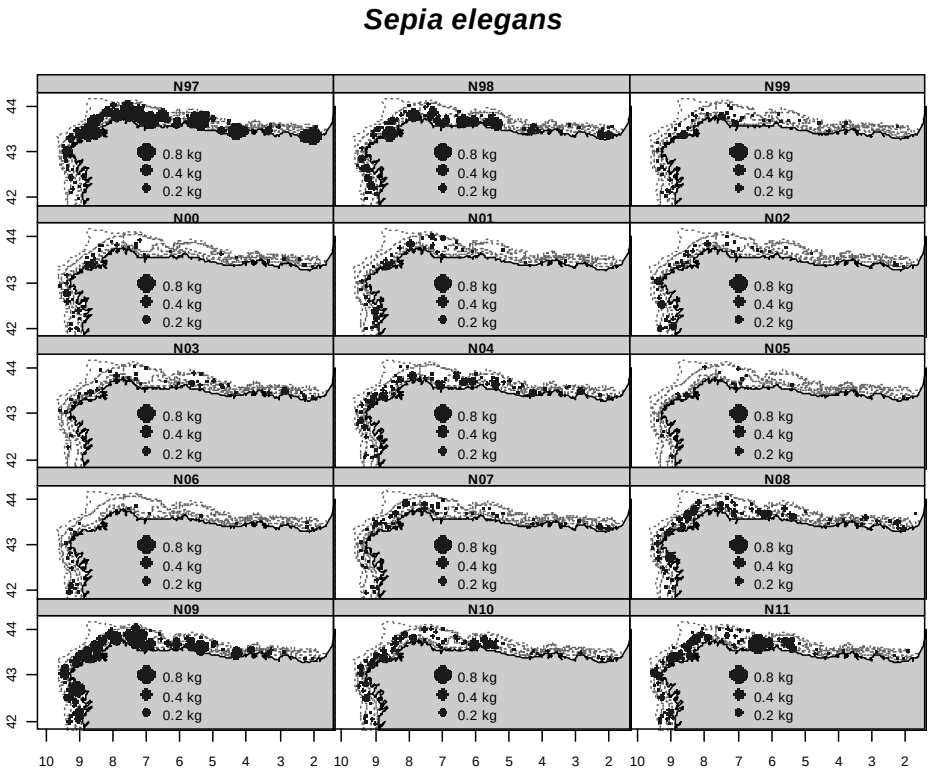

Figure 39. Geographic distribution of elegant cuttlefish (*Sepia elegans*) during DEMERSALES Survey time series (1997-2011).

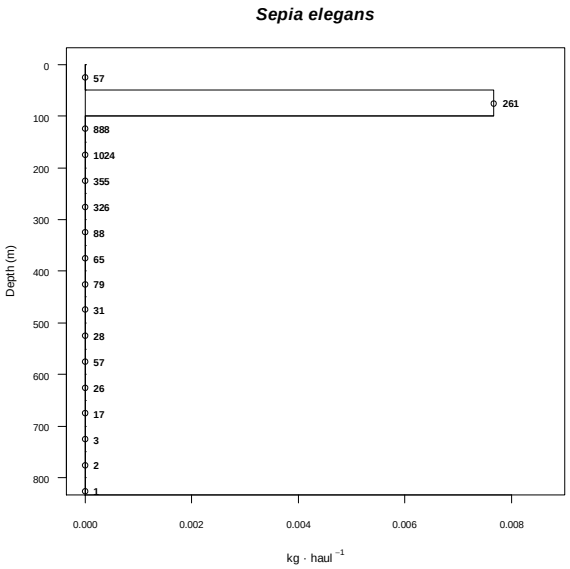

Figure 40. Bathymetric distribution of elegant cuttlefish (*Sepia elegans*) catches (ind. haul-1) by size range in DEMERSALES surveys (1997-2011) as a whole. Numbers to the right of each bar correspond with the number of hauls per depth range data from all the time series have been used to produce this figure.